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UTGITT AV

DET NORSKE VIDENSKAPS-AKADEMI

I OSLO

1931

II. HISTORISK-FILOSOFISK KLASSE

OSLO
I KOMMISJON HOS JACOB DYBWAD
A. W. BRØGGERS BOKTRYKKERI A/S
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1932

FURTHER ANALYSES OF OLD BRONZES

BY

JOHN SEBELIEN

AVHANDLINGER UTGITT AV DET NORSKE VIDENSKAPS-AKADEMI I OSLO
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OSLO
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1931

Fremlagt i fellesmøtet den 11. september 1931.

A. W. BRØGGERS BOKTRYKKERI A/S

In connection with the paper of dr. S. HOLTH in 1919[1] about some "Greco-roman and arabic bronze-instruments etc." were published my analyses of a lot of the instruments described by dr. HOLTH. The analyses showed, that most of these things were not real bronze. Only for one of the instruments did the contents of tin rise to 5,30 % while the contents of zincum in the samples was rather big, so that the name brass was mostly more suitable than bronze.

In a later paper[2] I gave an inquiring of the composition and the origin of the prehistoric bronzes, and I mentioned by this occasion the analyses I had made of some bronzelike samples from Norway. Further on in 1924 I read for the *British Association for the Advancement of Science* at Liverpool a paper on "*Early copper and its alloys*", containing a report of my analyses of old Egyptian and Mesopotamian bronzes. I am able to supply these reports with still some more analyses of samples of old bronzes, with which I have been furnished from different sources.

I. Dr. S. Holth had the kindness to give me for analyse the following samples, all originating from the "Collection Ustinow[3]"; but not mentioned in his paper[1].

1. An arrow-head.
2. A little ingot, dimensions about 7 cm. × 2 cm. × 1,5 cm.
3. A ring.

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[1] Videnskaps-Selskapets Skrifter, I. mat.-naturvidensk. Kl. 1919. No. 1, pg. 5.

[2] Videnskaps-Selskapets Skrifter, I. — „ — 1923. No. 5.

[3] Ancient Egypt, edited by Sir Flinders Petrie, London — New York 1924 p. 6.

4. A sound, 3 mm. thick, 15 cm. long.
5. A sphereformed knob of 2 cm. diameter, possibly a sort of handle.

The result of the analyses was:

1. arrow-head. — 74,80 % Cu, 12,22 % Sn, 4,42 % Zn, 5,89 % Pb, 1,10 % Fe, 0,31 % Co, 0,14 % As, 0,51 % Sb.
2. ingot. — 81,70 % Cu, 5,25 % Sn, 4,00 % Zn, 6,45 % Pb, 0,55 % Fe, tr. Co, 0,22 % As, 0,34 % Sb, 0,17 % P.
3. ring. — 85,50 % Cu, 2,98 % Sn, 8,35 % Zn, 2,98 % Pb, 0,44 % Fe, 0,07 % Ni + Co.
4. sound. — 81,75 % Cu, 2,85 % Sn, 9,90 % Zn, 4,42 % Pb, 0,64 % Fe, 0,08 % Ni + Co.
5. knob. — 80.50 % Cu, 14,23 % Sn, 0,21 % Zn, 3,52 % Pb, 0,28 % Fe, 0,14 % Ni + Co.

We find for these samples, that they mostly contain so much tin, that they certainly deserve the name of bronzes, but nevertheless the contents of lead and even of zincum is rather obvious, and bigger than in real pure bronzes.

II. *Bronze-nail* from the gates in the palace of King Shalmanesir the 2d. — At the same time as I got the bronze bands belonging to the said famous gates[4]. Sir Ernest Wallis Budge was kind enough to send along with them a nail, with which the bands had been fixed to the wooden doors. As the sample of the bands, the nail too was rather oxidized. It was heated in a current of pure hydrogen, and lost hereby 3,22 % of its weight. The result of the analysis does show the composition reckoned on the reduced substance.

For comparison we add the compositien of the band according to our former analyse:

	Cu	Sn	Pb	Fe	Zn	As
nail . .	81,1 %	11,40 %	0,47 %	0,51 %	0,19 %	0,12 %
band .	90,0 %	8,75 %	0,41 %	trace	tr.	tr.

III. *East asiatic bronzes from the collection Voretzsch.* In 1917 Dr. E. A. Voretzsch of the German legation in Norway had the kindness to supply me with some samples of his private

[4] look my paper in „Ancient Egypt" 1923 pg 13.

colletion of Chinese bronzes, collected during his former stay with the German legation in China. Some of our analyses relate to things mentioned by dr. VORETZSCH in his book on old Chinese bronzes.[5]

	Cu %	Sn %	Zn %	Pb %	Fe %	Ni %	Co %	As %	Sb %
1. Chinese Kettle-drum, T'ung Ku	67,43	12,07	—	17,80	0,63	—	—	—	—
2. Head of a Buddha-statue	75,80	13,36	0,21	3,28	0,28	0,14 (Ni + Co)		—	
3. Bronzepowder from Buddha-statue	82,54	11,92	0.95	2,81	0,30	0,12	—	0,19	0,98
4. Old Chinese knife-coin	36,60	3,71	—	54,01	0,98	0	tr.		1,06
	86,24	3,48	—	2,91					
	51,39	6,20	—	25,70	0,68	tr.	0		0,19 Ag

1. The analysed bit belonged to the Kettle-drum described by dr. VORETZSCH in his book pg. 237, fig. 124.
4. The sample in knife shape (Voretzsch pg. 37, fig. 1) from the Chou-dynasty (1122—249 b. Ch.) were used as coins in old Chinese times. The high content of lead was indeed very extraordinary. Certainly we find in the literature on bronze, analyses of samples with rather high contents of lead, but very seldom the figures will exceed 20 %. v. BIBRA says[6], that in the old Roman republican time the money-ingots ("as") were made with an addition of rather much lead to copper or bronze to make it more fusible, and he states in coins from that time contents of lead until 29,3 %. From younger times high contents of lead is to consider as a falsification for the tin; — the "plumbum nigrum" was used as a cheaper substitute for "plumbum album", or even it may be considered as substitute for copper. — Analyses of bronzes from the *Merovingian* age show contents of 10—44,06 % lead[7], and among 50 bronzes from China, Cochinchine and India, we find 2 chinese coins ("patec" and „tschen") with 31,4 and 42,2 % lead. Even for the japanese bronze Karahana, the

[5] E. A. Voretzsch: Altchinesische Bronzen. Jul. Springer, Berlin 1903.

[6] Ernst Freiherr v. Bibra: Die Bronzen und Kupferlegierungen der alten und ältesten Völker. Erlangen 1869.

[7] v. Bibra, l. c. pg. 202.

contents 44 % of lead is said to be the upper limit of this metal. The finding of 54,0 % of lead in our knife-coin, initiated us to repeat the analyse, and great was our astonishment, when we only found 2,91 % Pb. A third analyse of the same knife showed 25,30 % Pb. In the two instances, for which we have even the contents of copper, we see that the contents of copper varies inverse with the lead. The other metals are not submitted to so big variations, but it is rather curious, that a trace of cobaltum without nickel accompanies the excess of lead; a trace of nickel without cobaltum was shown in the part with more copper and less of lead. It seems, that if a so big quantity of lead is mixed with molten copper, the alloy in congealing will separate in parts with more and less contents of lead.

IV. For illustration of the question of an existing copper-age in Norway preceding the bronze age, I specially asked professor H. Shetelig, Bergen, to furnish me with some of the very *eldest* known finds of bronzes from this county. Professor Shetelig was kind enough to send me a piece of bronzelike metal from an old place from the stone-age at *Ruskenesset*, Fana in *Hordaland*. As already mentioned in my former paper[8] the analysis showed a real tin-bronze with 11,80 % tin and 63,36 % copper. The bit was rather rusty, but in unoxidised substance the contents would be 15 % tin, so there is no doubt, that this bit from the stone age means a real bronze and not only a copper bit.

I am in debt to professor H. Shetelig for some other specimens from the very oldest bronzes found in Norway. Here I take liberty to repeat the result of my analysis of them.

Museum etc.	Find and locality	Cu %	Sn %	Zn %	Pb %	Ag %	Fo %	Ni %	Co %	As %
1. B. 3295	Aurland 1879	?	9,34	—	—					tr.
2. B. 4191	Palstaff, Haaheim, 1883	84,48	6,66	3,64	1,03	tr	1,80			0,37
3. B. 3389	Axe, Ullensvang	87,15	5,86	1,66	0,80	—	2,17	0,31	—	0,28
4. B. 5921	Axe, Søndmøre	89,18	7,39	?	—	—	1,24	0,37	—	0,370

[8] l. c. my former paper 1923. p. 26.

IV. — Samples (old Norwegian) of bronzes from the Historical Museums in Oslo (C) and Bergen (B).

Museum etc.	Specimen and locality	Cu %	Sn %	Zn %	Pb %	Fe %	Ni %	Co %	As %	Sb %	S %
C. 7951	Axe; Raknes, Aukra, Møre	84,81	11,61	1,37	2,24	0,25	0	0	0,18	—	0,32
C. 18975	Celt, Boekvang, Trysil	87 62	8,80	0,96	0,40	0,37	0	0	0,07	—	0,03
C. 20830 b	Bracelet; Vere, Vanse, Lista	86,07	10,40	1,08	0,24	0,33	0,47	0	0,08	0,40	—
C. 5769	Part of celt; Vemmestad, Lyngdal	93,00	2,97	1,39	0,21	0,15	0	0	0,10	0	
C. 7756	Part of axe; Molland, Landvik	86,14	10,12	2,68	0,07	0,29					
B. 6657	Bonde from vikingage; Traa, Granvin	83.19	13,75	1,04	0	tr					
B. 901	Caldron; Eikanger, Hammer, Nordhordland	83,87	13.70	1,37	0,02	—					
B. 6360	Gravefound, vikingage: Mo, Øostad, Møre	84,36	11,02	0,92	1,02	0,38					
? ? [9]	? ? ?	81,15	14,69	0,53	0	tr					
B. 5459	Gravefound, vikingage. Bø. Ogne, Eikersund	81,96	17,19	0	0,10	tr					
C. 14108	Palstaff. Grimstad, Lunner, Hadeland	90,48	8,31	0	0,43	0					
C. 5159	Celt	86,38	3,47	0	2,25	0					
	Even from the museum at Oslo we got sample brought from the Norwegian Siberia expedition in 1914										
A. 752	axe collected by mr. Ørjan Olsen	72,40	13,75	0,12	0,86	13,64					

[9] I am very sorry to state, that through mistake I have missed the museum number of this sample. I have noted no. B 129; but the thing corresponding to this number is no bronze at all.

We see, that all these eldest specimens of "bronzes" in Norway are real tin-bronzes, and we have *no evidence for a copper age* in this country. Of course the alloy is not mixed here, but must be supposed to be imported from abroad, obviously from England.

V. — *Coins from the Numismatic Collection of the University, Oslo.* — In 1922 I received through the benevolence of dr. FONAHN at that time director of the said collection, some specimens for analysis, viz:

1. A chinese knife-shaped coin, looking like the piece mentioned above under III, 4, but belonging to the "Ming series", and of a more homogeneous composition than the specimen from the collection of dr. VORETZSCH The result of the analysis was

Cu %	Sn %	Zn %	Pb %	Fe %	Ni %	Co %	As %	Sb %	Ag %
47,0	1,57 1,53	0,99	43,85 43,50	tr.	tr.	0	0,91	tr.	tr.

It really shows a high content of Pb, but not so high, as in the knife-coin from the collection VORETZSCH. Even in other respects these too samples are not quite of the same composition.

The other specimens received, were the following:

	Cu %	Sn %	Zn %	Pb %	Fe %	Ni %	Co %	As %	Sb %
2. Roman „As", year 89—91 b. C.	88,20	7,76	0,2	0,56	tr.	0	0	0	0
3. Emerita Augusti Hispania time of Augustus	88,30	6,60	tr.	9,36	0,8	0,17	tr.	0	tr.
4. Corduba, Hispania...	90,70	7,82	0,17	0	tr.	0	0	tr.	tr.
5. Astapa, Hispania....	71,60	4.00	tr.	20,5	0,5	0	0	0,41	tr.
6. 10 Reis 1765, Portugal	98,01	0	0	1,10 1,15	0,11 0,09	0	0	0,12	0,77
7. 10 Reis 1737, Portugal	98,20 98,22	0,08 0.09	0	0,71 0,70	0	—	—	—	—
8. 80 Reis 1828, Brazil	98,83	0,15	0	0,33	0,15				
9. 2 sous 1791, France .	76,14	20,95 20,47	0,53	2,02 2,06	0,17 0,18	—	—	—	—
10. 5 centimes, Republ. Française, an 7.....	94,97 95,04	2.28 2,22	?	1,71 1,64					
11. 6 Farnisi, Naples & Sicily 1800.........	95,05 97,03	2,25 2,26		1,63 1,67					

The coins from Portugal and Brazil consist of so much copper, more than 98 %, and the content of the other metals is so small, that we are inclined to believe, that these small quantities are only accidental impurities, and these coins are to be considered to consist of only copper. — The other coins have so much tin, that they no doubt are to be judged as bronzes. The 2 — sous piece from France 1791 (no. 9) has an extraordinary big content of tin.

In the Roman *As* (No. 2) we did not found any lead. This is in accordance with v. Bibra[10], who mentions, that only in the eldest time there was put a rather big lot of lead to the *As* for making the metal of greater fusibility. At the time of *Augustus*, the coins did not contain any lead, or only very small quantities as accidental impurities. Later on, at the time of *Marc Aurel* we will find again rather high quantities of lead in the roman coins[11].

[10] l. c. pg. 74—75.

[11] Hammer; Gehalt des antiken Kupfergeldes. Zeitschrift für Numismatik. Berlin 26. Bd. 1908.

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